The Use of Honey in Cake, Cookie and Sweet Goods Production

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HONEY has always been held in high esteem as a food. Long before man knew of ways and means to extract syrups from plants with subsequent purification and crystallization, he used honey as his chief source of sweetener. Writings of early America refer to the use of honey. It continues today to enjoy a reputable place in the diet of the American people. Commercial use of honey in bakery products has not been extensive although more and more honey is finding a useful place in the production of special breads and cakes. Indications for 1952 are that honey will be abundantly available and that the quality will be excellent. This should be an inducement to the baking industry to increase the use of honey in its products.

Baking Formulas Are Available

Numerous papers have been written describing formulas requiring honey. A number of these publications may be found by consulting the references listed at the end of this report (1, 2, 3, 4, 5, 6 and 7).

Honey Has Special Properties

The special properties of honey which enhance the quality of cake include greater natural sweetening power (9, 10 and 11), flavor effects dependent on floral source (10, 11) and greater hygroscopicity (10, 11). Dunn and Bailey (8) observed that biscuits made with sucrose were hard and brittle compared to biscuits prepared with invert syrups.

Any sweetening agent that has free reducing groups, such as honey, can be expected to produce effects in cake different than from those produced by a nonreducing sugar such as cane or beet sugar (sucrose). The imparting of a golden brown crust to white cakes in a large measure can be attributed to the presence of a reducing sugar. Likewise, because of this color phenomena, honey may not be used in excessively high concentrations. Usually the concentration must be less than 50% of the total sugar.

The development of a brown crumb when higher concentrations of honey are employed is accentuated by an alkaline pH. Morgan (12) states that variation in pH of various honeys could be compensated for by using variable amounts of sodium bicarbonate as leavening agent. Lothrop and Bailey (10) however, demonstrated that as the pH of the batter was increased with sodium bicarbonate, the development of a brown crumb increased. Glabau (14) observed that batters adjusted to a neutral pH gave the best cake score.

While honey has been used for years and much practical experience has been gained, several problems continue to face the commercial user of honey. The object of this paper is to summarize some of the recent research findings on the use of honey in cake production. These findings treat with the subjects of variations in floral sources, maximum concentration, leavening agents, moisture retention and specifications for purchase of honey for use in cakes.

Fifteen Sources Studied

Fifteen different floral sources of honey were collected from widely scattered localities in the U.S. The chemical, grade and color analysis of these honeys are given in Table I. These data show the natural variation in color, moisture, active and total acidity, sugar content, levulose-dextrose ratio and the dextrin content.

Effect of Varying Concentration

The effects of varying the concentration of honey were investigated using a pound cake formula. When all the sucrose was replaced with an equivalent amount of honey, poor volume, dark crumb color and undesirable flavors resulted. Further experimentation showed that low volume could be overcome by the addition of small quantities of a common leavening agent such as sodium bicarbonate. However, concomitant with larger volume there was an increased extent of crumb darkening. Attempts to adjust the pH of the honey prior to its use in the bakery were unsuccessful because of darkening of the honey during storage. It was concluded that the most practical solution to the problem was to limit the concentration of the honey to less than 50% of the total sugar in the formula.

Honey in White Layer Cake

Experiments showed that 40% of the sucrose could be successfully replaced by honey in a high ratio white layer cake. The formula developed was as follows:

Ingredient	Percent
Flour	100
Sugar (honey and/or sucrose)	120
Emulsified shortening	45
Egg white	52
Liquid milk	96
Salt	3
Baking powder	5.0-6.0
Cream of tartar	0.5
Flavor (vanilla)	0.1

A summary of the quality of the cakes as related to floral sources of honey is shown in Table II. Only those quality scores are shown that were materially affected by the honey. Floral source had no appreciable effect on crust color, symmetry, grain and texture. The most prominent effect of floral source was on crumb color and aroma. The total quality score indicates that cakes made with 40% of honey substituted for equal amount of sugar, were, in most instances equal or superior to those made with 120% sucrose. It is evident that for white cakes selection of dark colored honeys, such as buckwheat or fall flowers, is to be avoided. These honeys also imparted undesirable flavors to the cakes.

Honey in Yellow Base Cake

Since color of honey may not be as critical in yellow base cake as in white cake, 11 different floral sources of honey were used in preparation of high-ratio, yellow base cakes. The formula was as follows:

Ingredient	Percent
Flour	100
Sugar (honey and/or sucrose)	120
Emulsified shortening	40
Whole eggs	40
Liquid milk	106
Salt	3
Baking powder	5-6
Flavor (vanilla)	.1

Major differences between cakes containing 40% honey substituted for equal amounts of sucrose and those containing 120% sucrose included contrasts in crumb color, taste and aroma. The summary of these effects is given in Table III. The effect of honey on crumb color appeared proportional to the Pfund color value. The effects of sweet clover, orange and cotton honey were particularly pleasing. Spanish needle caused an excessively yellow crumb suggesting that Spanish needle honey could create a yellow crumb comparable to the effect of whole eggs. All cakes made with honey appeared to have a more appealing flavor than those made with 120% sucrose. Cakes made with orange and tupelo honeys, particularly, retained a pleasing aroma and taste. All cakes made with honey were judged superior in eating qualities since they were not as crumbly as cakes made with 120% sucrose.

Effect on Moisture Retention

The yellow base cakes were stored at room temperature for seven days after which the moisture loss was calculated. The results are presented in Table IV. Statistical analysis of these data indicate, with the exception of mesquite and the two alfalfa honeys, that the honey cakes tend to retain more moisture than the sucrose cakes. The ability of the honey to increase the moisture retention did not appear to be correlated with the levulose-dextrose ratio or other chemical characteristics of the honey as presented in Table I.

Honey in Chocolate Cakes

Since color of honey might not be a factor affecting its use in chocolate cakes, concentrations greater than 40% were investigated. These studies showed that although color of honey was not a serious problem, the flavor was affected adversely. The cakes made with high concentrations of honey developed "burnt flavors" associated with a "browning reaction". Studies were continued using a 40% honey level and the following formula:

Ingredient	Percent
Flour	100
Sugar (honey and/or sucrose)	120
Emulsified shortening	45
Eggs	55
Milk	120
Cocoa	20
Sodium bicarbonate	3.5
Salt	3
Vanilla	0.1

The quality scores of chocolate cakes as affected by honeys are presented in Table V. Heartsease, horsemint, buckwheat and fall flower honeys produced undesirable flavor effects. The aroma and flavor of tupelo honey were pronounced. The flavor of other honeys seemed to be masked by the chocolate. The grain and texture appeared to be affected to vary-

Table I—Chemical Analysis, Color and Grade of Honeys

Honey—	H_2O %	Color*	Grade	Ash %	N_2 %	†Acidity ml.	pH	‡Total red. sugars %	‡Total sugars %	Su. crose %	L/D§	Dextrin %
Horsemint	19.8	40	C	0.21	0.11	56.5	3.6	73.2	77.1	3.7	1.08	0.32
Spanish needle	18.1	73	A	.20	.09	17.1	4.1	72.8	76.6	3.6	1.38	1.93
Buckwheat	19.7	119	C	.09	.21	38.1	3.9	72.0	75.5	3.3	1.06	.54
Fall flowers	17.8	111	A	.17	.14	28.8	4.0	75.3	78.4	2.9	1.02	.50
Cotton	16.4	26	A	.18	.09	25.4	3.9	76.9	80.3	3.2	1.02	.39
Sweet clover	17.1	25	A	.07	.00	16.0	3.9	73.6	80.1	6.5	1.22	.15
Mesquite	17.2	32	A	.09	.00	15.8	4.0	75.5	77.6	2.0	1.20	.20
Ariz. alfalfa	15.1	44	A	.22	.01	20.4	4.0	76.9	80.3	3.2	1.03	.57
Star thistle	16.4	49	A	.13	.04	42.0	3.7	74.2	76.6	2.3	1.06	.64
Tupelo	18.8	54	C	.10	.03	18.4	3.9	72.0	74.2	2.1	1.39	.25
Eucalyptus	17.7	64	A	.24	.04	25.3	4.0	73.2	75.7	2.2	1.17	.43
White clover	15.9	22	A	.07	.00	16.5	3.8	76.7	80.8	3.9	1.06	.12
Orange	16.4	21	A	.07	.01	16.6	3.8	74.2	81.8	7.2	1.16	.19
Heartsease	17.0	50	A	.07	.05	20.6	4.0	76.8	80.3	3.3	1.09	.03
Lt. amb. alf.	15.4	53	A	.16	.06	22.0	3.9	76.9	81.9	4.7	1.19	.12

*Color in millimeters Pfund. †Acidity reported as ml N/10 NaOH per 100 g. honey. ‡Total reducing sugars and total sugars calculated as invert sugar. §Levulose-Dextrose ratio.

Table III—Effect of Honey Source on Quality of Yellow Base Cake

Type of sweetening—	Volume in cc	Comparative cake score: Volume (15)	Crumb color (10)	Aroma (10)	Taste (20)	Total (100)
Sweet clover	1490	13	8	10	20	88
Mesquite	1500	14	7	10	20	88
Arizona alfalfa	1430	12	8	10	20	87
Star thistle	1420	12	8	10	20	87
Tupelo	1430	12	8	10	20	87
Eucalyptus	1460	13	7	10	20	87
White clover	1480	13	10	10	20	90
Orange	1505	14	10	10	20	91
Spanish needle	1500	14	5	10	20	86
Light amber alfalfa	1500	14	7	10	20	88
Cotton	1440	12	9	10	20	88
Sucrose	1640	15	5	8	16	79

Table V—Effect of Honey Source on Quality of Chocolate Cake

Type of sweetening—	Volume in cc	Comparative cake score: Grain (15)	Crumb color (10)	Aroma (10)	Taste (20)	Texture (10)	Total (100)
Sweet clover	500	15	8	9	20	10	97
Mesquite	500	15	8	9	20	10	97
Arizona alfalfa	505	15	8	9	20	10	97
Star thistle	525	15	8	9	20	10	97
Tupelo	510	15	8	8	19	10	95*
Eucalyptus	505	15	8	9	20	10	97
White clover	525	15	8	9	20	10	97
Orange	500	15	8	9	20	10	97
Heartsease	525	15	8	5	10	10	83**
Horsemint	515	15	8	5	12	10	85**
Spanish needle	510	10	8	9	18	8	88
Buckwheat	500	10	8	0	5	8	66**
Fall flowers	500	10	8	3	10	8	74**
Light amber alfalfa	510	12	8	9	20	9	93
Cotton	525	12	8	9	20	9	93
Sucrose	525	15	10	10	20	10	100

*Pronounced honey aroma and flavor. **Undesirable flavor and aroma.

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Table II—Effect of Honey Source on White Cake Score

Type of sweetening	Vol. in cc	—Comparative cake score— Crumb color (10)	Aroma (10)	Taste (20)	Total (100)
Sweet clover	495	9	10	20	98
Mesquite	510	8	10	20	97
Ariz. alfalfa	485	8	10	20	97
Star thistle	450	8	10	20	96
Tupelo	450	8	10	20	96*
Eucalyptus	460	7	10	20	95
White clover	500	9	10	20	98
Orange	465	9	10	20	97*
Span. needle	450	5	9	20	92**
Lt. amb. alf.	455	8	10	20	96
Cotton	450	9	10	20	97
Sucrose	445	10	10	19	97

*Pleasing aroma and taste of honey.
**Honey aroma of doubtful character.

Table IV—Effect of Various Honeys on Retention of Moisture During Seven-Day Storage

Name—	Rank	Crumb moisture after-seven-day storage	L/D ratio
Buckwheat	1	19.72	1.06
Horsemint	2	19.54	1.08
Spanish needle	3	19.40	1.38
Fall flowers	4	19.19	1.02
Tupelo	5	19.17	1.39
Heartsease	6	18.92	1.09
Eucalyptus	7	18.78	1.17
Orange	8	18.71	1.16
Star thistle	9	18.68	1.06
Sweet clover	10	18.46	1.22
Cotton	11	18.34	1.02
White clover	12	18.28	1.06
Mesquite	13	18.04	1.20
Arizona alfalfa	14	17.94	1.03
Light amber alf.	15	17.78	1.19
Sucrose	16	17.74	...

ing degrees by Spanish needle, buckwheat, fall flowers, light amber alfalfa and cotton honeys.

The colors of the cakes made with 40% honey were unlike the control. The sucrose cakes possessed a reddish-brown color while all the honeys were of a brownish color. This difference between the cakes can be attributed to the acid properties of the honeys. An addition of 10% more cocoa produced cakes made with honey that were comparable to those made with 120% sucrose.

Summary of Results

It has been observed from the quality of products made during this research that most of the variables in honey such as levulose-dextrose ratio, ash, dextrin and protein content do not produce any noticeable effects on cake. Among those honeys employed in this research, several have been shown to be practical for use in cake. These include cotton, sweet clover, mesquite, Arizona alfalfa, star thistle, tupelo, eucalyptus, white clover, orange and light amber alfalfa. These honeys improved the moisture retention and increased the shelf life of cakes. These same properties improved eating qualities since they tended to eliminate dryness and crumbliness. Superior sweetening power of honey tended to impart a richer flavor to all cakes. Orange and tupelo honeys are recommended when strong honey flavor is desired.

The concentration of honey suitable for practical use was found to be limited to one-third of the total sugar in the formula. Higher concentrations resulted in the formation of undesirable crumb color and flavor. A 1% increase in leavening agent is desirable when 40% honey is used.

The following proposed specifications are intended to be used only as a guide for both producers and users of honey.

Tentative Proposed Specifications for Honey for Use in Cake Products

1. All honey containers should be clearly labeled, showing U.S. grade, floral source, moisture content, and color in m.m. Pfund as well as U.S. Department of Agriculture color standards.

2. Honey for use in cake should be U.S. Grade "A" or "B" according to "U.S. Standards for Grades of Extracted Honey," effective April 18, 1951.

3. Honey should be treated at 160° F. for 30 minutes to retard granulation.

4. Predominant floral sources of buckwheat, fall flowers, heartsease, and horsemint honeys are not desirable for use in white, yellow or chocolate cakes.

5. Tupelo and orange blossom honeys are very useful for producing specific honey aroma and flavor in cakes. All other honeys are considered to be satisfactory.

6. Only honey classified as white by the U.S. grade and color standards is recommended for use in white cake.

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EDITOR'S NOTE: The accompanying article is the second of a series dealing with the place of honey in baked products. The first article appeared in the October, 1951, issue of The American Baker. We regret that supplies of reprints of the first article are exhausted; however, reprints of this report are available from the Editor, The American Baker, 118 S. Sixth St., Minneapolis 2, Minn.

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